Lesson: **Gas Laws (SCH3U)**

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| **Curriculum Expectations:**  F2.1 use appropriate terminology related to gases  and atmospheric chemistry, including, but not  limited to: *standard temperature, standard pressure,*  *molar volume,* and *ideal gas* [C]  F2.2 determine, through inquiry, the quantitative  and graphical relationships between the pressure,  volume, and temperature of a gas [PR, AI]  F3.5 explain Dalton’s law of partial pressures,  Boyle’s law, Charles’s law, Gay-Lussac’s law,  the combined gas law, and the ideal gas law  A1.5 conduct inquiries, controlling relevant  variables, adapting or extending procedures as  required, and using appropriate materials and  equipment safely, accurately, and effectively, to  collect observations and data  A1.6 compile accurate data from laboratory and  other sources, and organize and record the data,  using appropriate formats, including tables, flow  charts, graphs, and/or diagrams  A1.8 synthesize, analyse, interpret, and evaluate  qualitative and quantitative data; solve problems  involving quantitative data; determine  whether the evidence supports or refutes the  initial prediction or hypothesis and whether it is  consistent with scientific theory; identify sources  of bias and error; and suggest improvements  to the inquiry to reduce the likelihood of error  A1.10 draw conclusions based on inquiry results  and research findings, and justify their conclusions  with reference to scientific knowledge | **Learning Goals:**  We will be able to...   * plan and conduct an experiment that explores the behaviour of a gas * explain Boyle’s law, Charles’s law and Gay-Lussac’s law |
| **Success Criteria:**   * conduct inquiries using appropriate materials and equipment safely, accurately, and effectively * control relevant variables * identify an appropriate independent and dependent variable * collect observations and data * organize data in appropriate table format * organize data in appropriate graph format * analyze table and/or graph to find a relationship (e.g., between pressure, temperature, and volume of a gas) * draw and justify a conclusion based on data * state Boyle’s law, Charles’ law, and Gay-Lussac’s law using appropriate terminology and based on the analysis of inquiries | |
| **Type of feedback and when:**  *e.g., At what point(s) in the lesson might students make use of teacher feedback? What feedback could be gathered to inform instructional decisions? Any opportunities for feedback through peer- and self-assessments?*   * circulate and provide feedback on scientific investigation skills using a rubric/checklist | |

**Lesson Plan (2 x 75 min periods)**

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| **Minds On (30 min)**  ⬩ Establishing a positive learning environment  ⬩ Connecting to prior learning and/or experiences  ⬩ Setting the context for learning | **Connections**  L: Literacy  ML: Mathematical Literacy  AfL: Assessment **for** Learning  AaL: Assessment **as** Learning  AoL: Assessment **of** Learning  DI: Differentiated Instruction |
| **Whole Class 🡪 Demonstration**   * Begin with a teacher demonstration: Ivory soap in microwave   (see <http://www.youtube.com/watch?v=7lAOOwMNodA>)   * Students make observations and generate “I Wonder” questions * Consider using the “Steps to Inquiry” posters from Smarter Science (<http://smarterscience.youthscience.ca/>) or an OWLH Chart   **Pairs & Whole Class 🡪 Think-Pair-Share**   * Ask the class “What do you think is happening?” * In pairs, students discuss their ideas and then share with the whole class * Consider using probing questions, if necessary, to get students thinking about the air trapped in the soap   **Whole Class 🡪 Setting the Stage**   * Share the first learning goal: By the end of this lesson, you will be able to plan and conduct an experiment that explores the behaviour of a gas based on your own “I wonder” question * Co-construct the success criteria for conducting a scientific investigation: * conduct inquiries using appropriate materials and equipment safely, accurately, and effectively * identify an appropriate independent and dependent variable * control relevant variables * collect observations and data * organize data in appropriate table format * organize data in appropriate graph format * analyze table and/or graph to find a relationship (e.g., between pressure, temperature, and volume of a gas) * draw and justify a conclusion based on data collected * Students choose a question they want to investigate. Consider using probing questions to have students consider variables that relate to volume, pressure and temperature of the gas | AfL: sharing learning goals  AfL: co-constructing success criteria |

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| **Action (90 min)**  ⬩ Introducing new learning or extending/reinforcing prior learning  ⬩ Providing opportunities for practice and application of learning (guided 🡪 independent) | |
| **Small Groups 🡪 Planning & Conducting an Experiment**   * Students   + plan a procedure and provide it to the teacher for approval prior to conducting the lab   + conduct the lab once procedure is approved   + collect, organize, and analyze data   + draw and justify a conclusion * Circulate and provide feedback, when necessary. Consider using a rubric/checklist to assess scientific investigation skills (based on success criteria). * Students record information on chart paper to share with the whole class | AfL: Rubric/Checklist/ Observations |
| **Consolidation and Connection (30 min)**  ⬩ Helping students demonstrate what they have learned  ⬩ Providing opportunities for consolidation and reflection | |
| **Whole Class 🡪 Sharing and Discussing Results (BANSHO style)**   * Students share their experimental results and analysis with the whole class * Choose a few groups that have chosen a question that relates to one of the three gas laws. Using probing questions or open class discussion, help students determine a relationship between pressure, temperature, and volume of a gas. If students haven’t chosen an experiment that relates to pressure, temperature, and/or volume of a gas, then consider having students complete the homework gizmo prior to labelling the gas laws and sharing the second learning goal. * Label the three gas laws as Boyle’s, Charles’s, and Gay-Lussac’s law * Share the second learning goal: By the end of the lesson, we will be able to explain Boyle’s law, Charles’s law and Gay-Lussac’s law   **Individually 🡪 Exit Card (R.E.R.U.N.)**   * Students individually complete a RERUN exit card * Use the exit cards to assess the learning goals and guide further instruction   **Individually 🡪 Homework**   * Students complete the “Boyle’s Law and Charles’s Law” gizmo (<http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=422>) | AfL: Exit Card/RERUN |

***RERUN* Exit Card**

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| **R**ecall: Summarize what you did in the experiment. |
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| **E**xplain: Explain the purpose of the experiment. |
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| **R**esults: Describe the results of the experiment and what they mean. |
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| **U**ncertainties: Describe what you are still unsure about. |
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| **N**ew: Write at least two new things that you learned from this experiment and the experiments of your peers. |
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(Source: *Science Formative Assessments* by Page Kelly)

**Checklist: Scientific Investigation Skills**

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|  | **Student Name** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Criteria** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Uses appropriate materials and equipment safely |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Uses appropriate materials and equipment accurately |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Identifies the independent variable |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Identifies the dependent variable |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Properly controls all other variables |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Collects data using a table |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Organizes data in proper table format |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Uses a graph or table to analyze data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Writes a conclusion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Justifies conclusion based on analysis of data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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